Nuclear Science Program at Triangle Universities Nuclear Laboratory (TUNL)

I. Introduction

The Triangle Universities Nuclear Laboratory (TUNL) is a joint venture between Duke University, North Carolina State University, and the University of North Carolina at Chapel Hill. The three university groups have their individual DOE budgets. The following numbers refer to TUNL as a whole:

Funding	FY2000: $3.59M		FY2001: $3.69M		
Staffing:	Perm Ph.D.	Tech/Admin	Postdocs	G.S.	Undergraduates
FY2000:	20	9*	8	31	12 (REU) + 3
Users:	Total #	Ph.D./G.S./Others		DOE/NSF/other US/Foreign	
FY2000:	85	25%/75%/ -----		90% / 10% / ----- / -----	

* includes 2 Nuclear Data personnel

TUNL's experimental facilities include accelerators that provide intense beams of polarized protons and deuterons covering the energy range from 20 keV to 20 MeV. Intense polarized neutron beams are available from 350 keV to 35 MeV. Linearly polarized and nearly monoenergetic γ-ray beams are available from 2 to 20 MeV at HIγS (High-Intensity γ-ray Source) located at the Duke Free-Electron Laser Laboratory. TUNL's polarized target facilities are capable of polarizing nuclei from ^{1}H to ^{165}Ho.

The research facilities where TUNL researchers work are shown in Fig. 1. Inside of the triangle are the local TUNL research laboratories. The circles attached to the triangle represent off-site facilities, except for the HIγS facility presently under development, which is located behind the TUNL building. For many years about 25%-30% of TUNL's research activities have been conducted off-site. This percentage is projected to continue. When HIγS becomes fully operational, other TUNL activities will be phased down in exchange of the new research opportunities at HIγS.

The three major research areas are:

- Fundamental-symmetry studies, including double-beta decay and neutrino physics
- Nuclear astrophysics, with emphasis on measurements which are important for both the solar-neutrino problem, and stellar evolution and nucleosynthesis
- Study of few-nucleon systems, with emphasis on three-nucleon force effects in the three-nucleon continuum

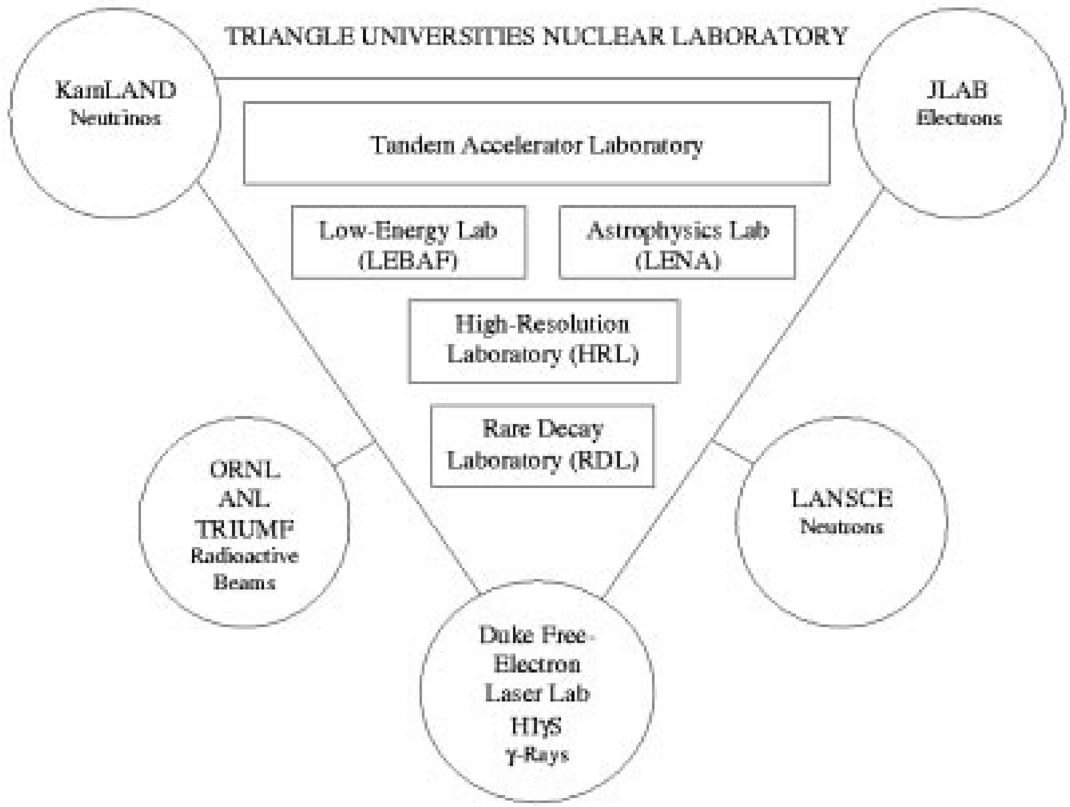

Fig. 1 Research facilities used by TUNL

II. Main new research initiatives:

a) Nuclear Astrophysics, Few-Body Physics and χPT studies using monoenergetic and polarized, high-intensity γ-ray beams at HIγS (High-Intensity γ-ray Source at the Duke Free-Electron Laser Laboratory)

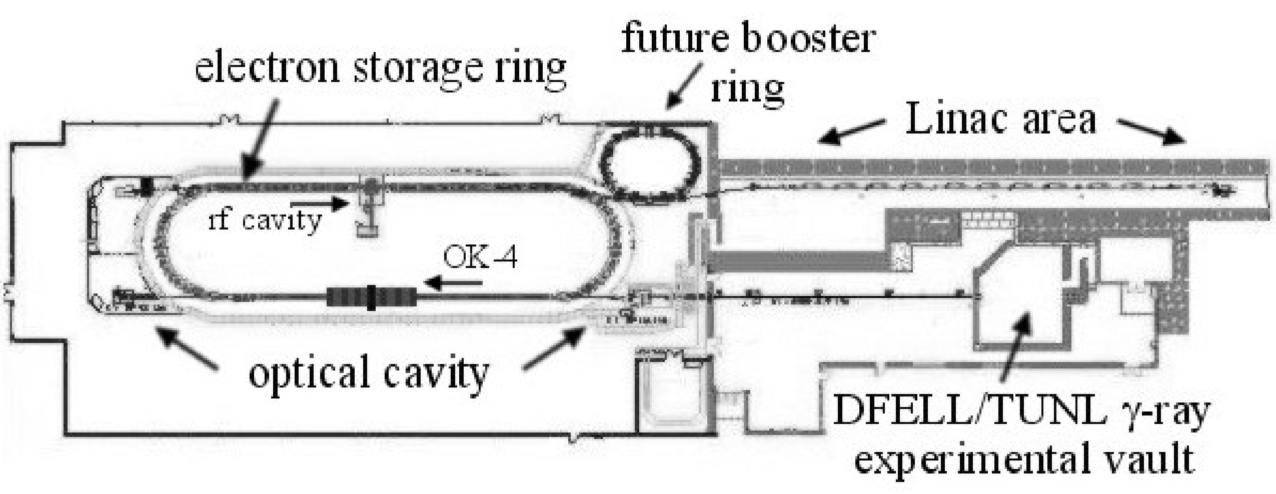

Fig. 2 Layout of HIγS facility with planned 1.2 GeV booster injector and existing γ-ray vault

b) Neutrino Physics at KamLAND and at the Oak Ridge Laboratory for Neutrino Detectors (ORLaND)

TUNL has almost completed the veto detector for KamLAND (left side of Fig. 3) and is currently involved with design studies for the big neutrino detector (right side of Fig. 3) at ORLaND located in a bunker near the SNS target.

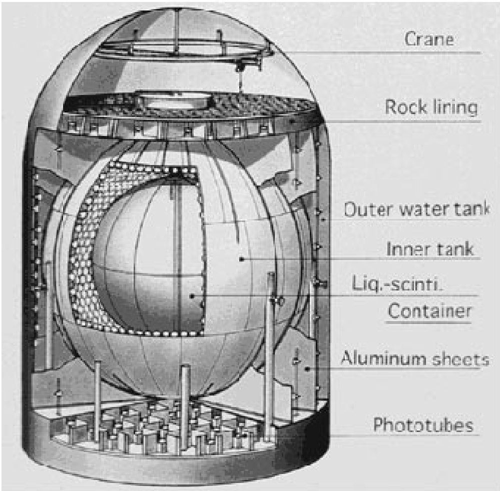

Fig. 3 KamLAND and ORLaND

c) Large-scale ^{76}Ge double-beta decay experiment to search for the zero-neutrino double-beta decay (Majorana project at the Waste Isolation Pilot Plant, WIPP, Carlsbad, NM)

Present TUNL Apparatus:
2 Ge detectors
1 NaI annulus

Guernica Apparatus:
14 Ge detectors
1 enriched/segmented
1 NaI annulus

Majorana Apparatus:
210 Ge detectors
All enriched/segmented

Fig. 4 TUNL's 3-phase approach to search for the (0ν, 2β) decay of ^{76}Ge at WIPP

III. Main new facility upgrades:

a) Upgrade of HIγS (installation of booster injector) to extend the γ-ray energy range of currently 2 – 20 MeV to a maximum energy of 220 MeV (see Fig. 2). This upgrade is the goal of a $3 M proposal to DOE. Duke has built the γ-ray target room and will contribute an additional $1 M to the booster injector project. Tentatively, the upgrade project is scheduled to start during the summer of 2001. High-intensity, high-energy, and polarized (linear or circular) γ-ray beams are expected to be available early in 2005.

b) Upgrade of detector systems for LENA (Laboratory for Experimental Nuclear Astrophysics)

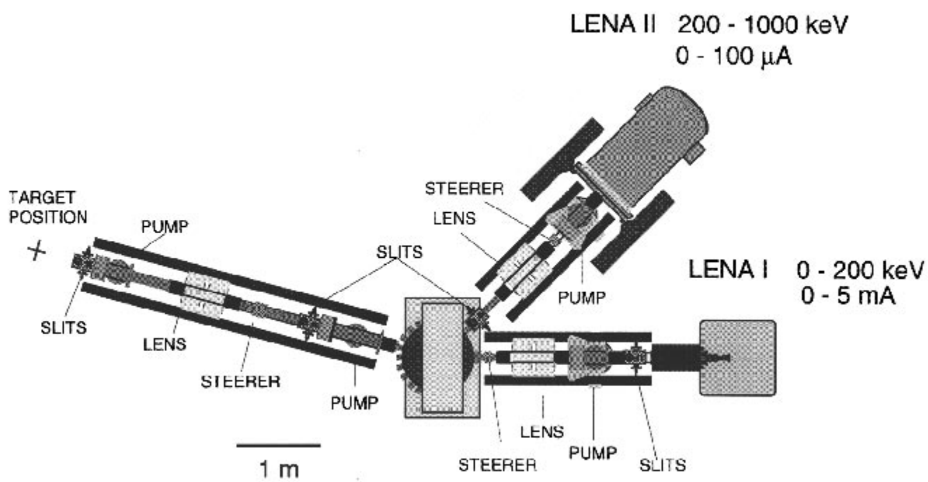

Fig. 5 LENA with its two accelerators (200 kV high-current accelerator and 1 MV Van de Graaff)

IV. If the FY2001 budget is going to be the baseline budget for TUNL in the years to come, TUNL can not fully exploit the capabilities of its new and unique Laboratory for Experimental Nuclear Astrophysics (LENA). In addition, TUNL's new efforts in neutrino physics (presently at KamLAND in Japan, and in the future at ORLaND) and the planned relocation of TUNL's double-beta decay activities to an underground facility (WIPP) will require additional resources. A 10% increase over the FY2001 budget would allow TUNL to excel in these exciting fields and to establish leadership roles. As a by-product, TUNL would continue to get its share of top quality graduate students. So far TUNL has maintained its 35 year average of slightly over 30 Ph.D. students at any given time (which results in 5 Ph.D's. per year). However, considering the enormous competition from more fashionable fields like nanoscience and atom trapping etc., it is becoming increasingly more difficult to maintain these numbers.